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January 22, 2002

Reference No. 019023-15

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77 West Jackson Blvd.  
Chicago, Illinois 60604

**OVERNIGHT COURIER**

✓  
K.A.  
2/7/02

Dear Mr. Adler:

Re: Groundwater Pre-Design Work Plan Transmittal  
Waukegan Manufactured Gas and Coke Plant Site  
Waukegan, Illinois

Enclosed, please find one copy of the document entitled "Groundwater Pre-Design Work Plan, Waukegan Manufactured Gas and Coke Plant Site, Waukegan, Illinois" (GWPDWP). The GWPDWP has been prepared on behalf of the "Performing Respondents" by Conestoga-Rovers & Associates (CRA) and Barr Engineering (Barr) in accordance with the approved Remedial Design Work Plan, Waukegan Manufactured Gas and Coke Plant Site (RDWP). The RDWP was prepared consistent with the Remedial Design Scope of Work (RD SOW) which is Attachment II to the Administrative Order on Consent for Remedial Design (RDAOC) at the Waukegan Coke Plant Site, USEPA Docket No. V-W-01-C-651.

Two copies of the enclosed GWPDWP have been transmitted to CH2M Hill of Milwaukee, Wisconsin. Additionally, two copies of the GWPDWP have been transmitted to Ms. Erin Rednour of the Illinois Environmental Protection Agency.

Please feel free to contact me should you have any questions or comments on this matter.

Yours truly,

CONESTOGA-ROVERS & ASSOCIATES

Steven J. Wanner

SJW/ko/2

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# **GROUNDWATER PRE-DESIGN STUDY WORK PLAN**

**WAUKEGAN MANUFACTURED GAS AND COKE PLANT SITE  
WAUKEGAN, ILLINOIS**

**JANUARY 2002**

**REF. NO. 019023 (3)**

This report is printed on recycled paper.

**Prepared By:**

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## 1.0 INTRODUCTION

This document presents the Groundwater Pre-Design Study Work Plan (GPDSWP) for the Waukegan Manufactured Gas and Coke Plant site, Waukegan, Illinois (Site). The GPDSWP has been prepared on behalf of the "Performing Respondents" by Conestoga-Rovers & Associates (CRA) and Barr Engineering (BARR) in accordance with the Remedial Design Work Plan, Waukegan Manufactured Gas and Coke Plant Site (RDWP). The RDWP was prepared consistent with the Remedial Design Scope of Work (RD SOW) which is Attachment II to the Administrative Order on Consent for Remedial Design (RDAOC) at the Waukegan Coke Plant Site, USEPA Docket No. V-W-01-C-651. The RDWP was approved by the United States Environmental Protection Agency (USEPA) in a letter dated December 11, 2001. The GPDSWP is Task G1 of the RDWP.

### 1.1 GPDSWP ORGANIZATION

The GPDSWP has two major elements; Three-Dimensional Computer Modeling and a Nitrification Study. Each major element is addressed in separate sections of this GPDSWP. Section 2.0 presents the Modeling component of the GPDSWP.

Section 3.0 presents the Nitrification Study. Both major elements include a separate introduction to the work to be completed and present a summary of what work is planned.

## 2.0 THREE-DIMENSIONAL COMPUTER MODELING STUDY

### 2.1 GROUNDWATER MODELING

This Work Plan describes the Groundwater Pre-Design Study work for groundwater flow and solute transport modeling at the Site. The purpose of the groundwater modeling and evaluation is to assist in design of groundwater treatment cells and to assist in estimating the performance of these cells across the Site. The model is also intended to be used in the future as the basis for predicting the performance of monitored natural attenuation (MNA).

### 2.2 OBJECTIVES

The groundwater modeling work has the following objectives:

- quantitatively evaluate the Pilot Study's performance;
- guide the design of extraction/reinjection (E/R) cells for the Phase 1 groundwater remedy;
- assist in determining sequencing options for the Phase 1 cells; and
- estimate the operation time for the cells to reach goals.

This work will involve three-dimensional groundwater flow and solute transport modeling, evaluations and comparisons of modeling results to Site data, and integrating the modeling and other evaluations to provide the basis for the design of the groundwater treatment cells. The work will include preliminary prediction of the concentrations of selected groundwater contaminants at the end of the treatment cell portion of the groundwater remedy, for preliminary evaluation of the protection of surface water. The primary work on evaluating the relationship between the Phase I cell treatment remedial action and the Phase II MNA will be presented in the MNA Study.

### 2.3 MODELING CODES

The treatment cell design work will have a significant groundwater modeling component. Computer groundwater modeling will include the following codes:

1. Three-dimensional flow modeling using the code MODFLOW (McDonald and Harbaugh, 1988; Harbaugh and McDonald, 1996). A high level of vertical

discretization may be used in order to account for the stratification of contamination. This will also allow for the modeling of vertical anisotropy and stratification of horizontal hydraulic conductivity if needed.

2. Solute transport modeling using MT3D-MS (Zheng, 1992; Zheng and Wang, 1999) and/or RT3D (Clemment, 1998) in conjunction with MODFLOW.
3. Calibration will be performed using the automated inverse model PEST2000 (Watermark Computing, 1999) with MODFLOW and the solute transport codes, as well as by manual calibration methods or a combination of the manual and automated methods.
4. Input and output data will be managed in ArcView GIS, interfaced with the graphical user interface GMS 3.1 or GMS 4.0. GMS allows for grid-independent model set-up, which may be used when evaluating the progression of the remedial system's implementation. The graphical user interface Groundwater Vistas is also available to be employed as needed.
5. Modeling results may be portrayed using several codes: ArcView, Surfer, TecPlot, and GMS.

Assessment of the effects of groundwater contaminants of concern (COCs) on surface water will use the Feasibility Study (FS) model of groundwater mixing with surface water (see FS Appendix 2D)

## **2.4 SITE MODEL CONSTRUCTION AND CALIBRATION**

Construction and calibration of the groundwater flow model will take place at the same time. Boundary conditions for this Site are relatively obvious as this Site resides on a peninsula surrounded on three sides by Waukegan Harbor and Lake Michigan. The northern boundary will likely be a no-flow, specified-head, or constant flux boundary with the location to be determined during model construction.

The model will be vertically discretized into multiple layers in order to simplify accounting for the stratification of contamination. This will also allow for the modeling of vertical anisotropy and stratification of horizontal hydraulic conductivity as needed. Information to define the bottom of the model will be taken from the elevation data for the till layer that underlies the surficial unconsolidated deposits.

The model calibration process will use ASTM D 5981 (Standard Guide for Calibrating a Ground-Water Flow Model) as a guide for the automated and manual calibration of the groundwater flow model. The groundwater flow model will be constructed and initial

aquifer parameters will be incorporated into the model from the previously collected data and from previously constructed analytic element groundwater models of the Site. Much of these data are in an ArcView-compatible form and are readily portable to MODFLOW through GMS. Once the initial flow model is constructed, it will be calibrated to observed "steady-state" water levels. This first calibration will be performed using PEST2000 or manual calibration methods.

After the initial model calibration, a second calibration will be performed to simulate the Pilot Project observations. For this calibration, the Pilot Project's pumping and injection will be incorporated into a MODFLOW model. An initial distribution of selected COCs will be incorporated into the solute transport model as initial conditions (the distribution will be based on observed data). The second calibration will be used to refine hydraulic parameters using the flow, water level, and bromide tracer data from the Pilot Project. The second calibration will also be used to estimate Site-specific solute transport parameters for ammonia, arsenic, and phenolics. The calibration will be undertaken using manual methods and, as appears useful, PEST2000. The calibration will aim to reproduce selected key outcomes of the Pilot Project, such as the timing and rapid decline of the COC concentrations observed in the Pilot Project monitoring wells. This second calibration will be focusing on solute transport parameters such as dispersivity, effective porosity, and sorption parameters. The calibration is intended to support the selection of appropriate transport parameters for the most important conditions governing cell performance: groundwater flow and advection for the key constituents.

## **2.5 EVALUATION OF CELL CONFIGURATIONS**

A coupled flow and solute transport model will be the primary tool for designing the Phase 1 groundwater E/R system. Using the model calibrated to the Pilot Project's performance, the well configuration will be scaled up to the size of a full cell (the FS assumed 10 extraction wells and 20 infiltration wells). A preferred full-scale cell configuration will be selected based on modeling runs that examine the effects of different extraction rates, well spacing, and well designs on the time necessary to flush the cell and maintain a capture zone.

Once a preferred cell configuration (or cell parameters) are selected, this evaluation will be performed at various locations within the model that would be representative of different cell configurations. Three to four different E/R configurations are anticipated in order to account for variations in aquifer parameters, hydraulic gradients, saturated aquifer thickness, and physical constraints that will be encountered over the entire Phase 1 area. Solute transport simulations for these configurations will then be



performed to estimate preliminary performance curves for the cells. Initial contaminant distribution at the Site for purposes of transport modeling will use data in the Groundwater Plume Delineation Report (December 11, 2001) and will be supplemented with data from the Pilot-Project, RI, and FS reports. Arsenic, phenols, ammonia<sup>4</sup> are the target compounds for solute transport modeling. + benzene?

A cell exit program will be designed using the preferred cell configuration. The Pilot Project data and model results will be used to develop a system for determining the appropriate operation time for a cell.

## 2.6 SIMULATION OF PHASE 1 IMPLEMENTATION

Following evaluation of cell size, configuration, and features, the full Phase 1 implementation will be simulated by staging the implementation of the cells. The groundwater remediation area will be identified initially using the same approach as in the FS (see FS Appendix 4-B).

This simulation work may also be able to estimate the likely performance and duration of operation of the Phase 1 system and the associated mass removal in the groundwater treatment zone. An example sequence of cell operations will be developed in this simulation. The primary outcome of the sequencing simulation is an estimate of the total reduction in COC concentrations over the groundwater remediation area.

A byproduct of this portion of the simulation is an estimate the quality of the extracted water that is influent to the treatment system. Although the details of cell implementation may not be captured in the modeling, a reasonable basis for developing a cell operation plan can be obtained from the modeling results. The cell operation plan would include determining the sequencing of cells (i.e., how new groups of cells are placed into operation) in order to keep the influent quality constant and how this would affect the cell flow rate. This will provide the basis for a preliminary integration of the cell operation and the treatment system operation.

The end condition of the Phase 1 implementation simulations will be a prediction of the concentrations of the key contaminants after completion of Phase 1, which will also be the predicted initial condition for Phase 2 MNA. Simulating the performance of MNA after the completion of Phase 1 will be addressed in the MNA Study.

## 2.7 PRESENTATION OF MODELING OUTCOMES

The results of the groundwater modeling will be presented to EPA at the end of this modeling study. The following topics will be addressed:

Methodology and approach:

- overview of model construction, calibration, and parameter selection; and
- comparison of model results to data collected from pilot-scale test.

Review of the design decisions based on the modeling:

- predicted effects of scale-up of pilot test to Site;
- design of cells (well spacing, pumping rates, injection rates, etc).
- outcomes of sequencing simulation; and
- estimate of operation time for the cells to reach goals.

Additional Information:

- influent concentrations to the treatment system; and
- preliminary evaluation of the protection of surface water following Phase I implementation.

A report of the modeling results will be provided in the Remedial Design Report

### 3.0 NITRIFICATION STUDY WORK PLAN

#### 3.1 NITRIFICATION STUDY INTRODUCTION

This Nitrification Study Work Plan (NSWP) is based on the results of a Groundwater Treatability Study conducted as part of a Groundwater Pilot Project completed in 2000-2001 (Pilot Project Report, July 2001, CRA). The 2000-2001 Groundwater Treatability Study will be referred to as the Pilot Project Treatability Study in this NSWP.

During the Pilot Project Treatability Study potential technology for treating groundwater collected at the Site was evaluated in two parts; pretreatment for arsenic removal and biological treatment for removal of organic constituents, ammonia, and thiocyanate. It was determined that Fenton's reagent treatment, a mixture of ferrous sulfate and hydrogen peroxide, can be successfully applied for removal of arsenic (generally 80 to 90 percent). During the same treatment partial removal (approximately 15 percent) of organic contaminants and thiocyanate was also achieved.

Biological treatment of pretreated groundwater from the Site applying sequencing batch reactor (SBR) technology removed up to 99 percent of phenols, >95 percent thiocyanate and >90 percent of all specific organic compounds during the Pilot Project Treatability Study.

Nitrification in the SBR system was clearly established achieving up to 60 percent of ammonia removal. However, one of the conclusions of the Pilot Project Treatability Study was that the test was not planned or configured to operate long enough to fully acclimate the biomass to a very high concentration of ammonia in the groundwater ( $\text{NH}_3\text{-N}$  up to 2,000 mg/L). As a result stable nitrification was not achieved throughout the Pilot Project Treatability Study.

The Pilot Project Report recommended that a follow up bench-scale system be operated to address the following objectives:

1. longer acclimatization and operation period so that stable biological treatment is achieved;
2. parallel operation of biological treatment process with and without arsenic pretreatment to monitor the fate of the arsenic in the process; and
3. representative influent concentrations as opposed to the startup concentrations used in the Pilot Project Treatability Study.

The purpose of this NSWP is to plan and describe a long-term operation bench-scale system that will define the parameters for successful scale up of a biological groundwater treatment system. The operation of two separate SBR reactors will be investigated. One will be fed with pretreated groundwater while the other will be fed with non-pretreated groundwater.

The optimized pretreatment procedure developed in the Pilot Project Treatability study will be applied to the first SBR.

At least 100 gallons of groundwater for the treatability study will be collected from the Site and will be shipped to the CRA Treatability Laboratory. The sample will be the subject of initial tests to confirm the efficiency of the pretreatment procedure.

The biomass used in the study will be collected from a full-scale activated sludge treatment plant that treats coke wastewater. The source is expected to be the Bethlehem Steel plant in Buffalo, New York, the same as that used in the Pilot Project Treatability Study.

### 3.2 SAMPLE COLLECTION STORAGE AND HANDLING

The Pilot Project Report demonstrated that contaminant concentrations declined significantly over the first 10 days of pumping and remained at reduced levels under the various pumping scenarios that were tested under the Pilot Project. The Pilot Project Treatability Study was conducted on groundwater from the first 2 days of pumping and as a result represented worst case groundwater quality. The influent concentrations to a full scale treatment plant will be lower than those used in the Pilot Project Treatability Study as each pumping cycle will continue for many weeks.

This Nitrification Study will be conducted with groundwater that is representative of expected long-term groundwater quality to be more representative of expected field conditions. Preliminary Groundwater Modeling results will be used to confirm that the reduced concentrations measured in groundwater from the Pilot Project can reasonably be expected at other locations within the zone of contaminated groundwater.

Upon confirmation that the reduced concentrations are representative of longer-term groundwater pumping conditions, a representative groundwater sample will be collected. The sample will be collected from existing extraction well EW-2. EW-2 will be pumped to storage until field measured conductivity is in the range of 1/3 to 1/2 of its original Pilot Project value.

At EW-2 pumping of the rate of 1 liter per minute reduced the conductivity to 5.61  $\mu\text{mho}/\text{cm}$  or 44 percent of its original value of 12.74  $\mu\text{mho}/\text{cm}$  after 12 days. During this time approximately 4,500 gallons of groundwater was removed from EW-2. The sample for the Nitrification Study described in this GWPDSWP will be collected when the conductivity is less than 6  $\mu\text{mho}/\text{cm}$  for 4 hours. The conductivity will be measured hourly when pumping begins. The measurement frequency will be decreased when a conductivity trend is observed until the conductivity value drops below 7  $\mu\text{mho}/\text{cm}$ . At that time hourly readings will again be recorded until the sample is collected and the pump turned off.

It is expected that the conductivity objective will be achieved faster than during the Pilot Study and that something less than 4,500 gallons will be pumped to waste before sample collection. However, as volumes are difficult to precisely predict, a 20,000-gallon storage tank will be provided. Stored water will be characterized and properly disposed off Site following the sample collection.

It should be noted that other parameter concentrations declined in a pattern similar to the conductivity decline.

To ensure the same groundwater quality during each study the following procedures will be applied:

1. containers will be kept at  $\sim 5^{\circ}\text{C}$  and well mixed before the treatment;
2. samples for treatment will be collected in equal volumes from each of the storage containers; and
3. before treatment each batch sample will be analyzed for the following parameters pH, oxidation/reduction potential (ORP), total suspended solids (TSS), turbidity, conductivity, chemical oxygen demand (COD), soluble COD (SCOD), ammonia, nitrate, cyanide, phenols, thiocyanate, and base/neutral, and acid extractable organic compounds (the base/neutral fraction is unlikely to produce useful results and will be deleted after two analyses).

### 3.3 PRE-TREATMENT

#### 3.3.1 INITIAL SCREENING TESTS

The main purpose of the screening tests is to confirm the efficiency of the pretreatment procedure developed in the Pilot Project Treatability Study for the new groundwater sample. The dose of the chemicals will be adjusted according to the chemistry of the new groundwater sample.

The following procedures will be applied:

1. 1 liter of groundwater samples will be mixed with 1,000 mg of humates. Then 60 mg of ferrous sulfate will be added during vigorous mixing. Finally 30 mg of hydrogen peroxide will be added and the mixture will be stirred for another 60 minutes;
2. treated samples will be analyzed for TSS, arsenic, TOC, phenols and thiocyanate. The test will be conducted in triplicate and the results will be averaged; and
3. if chemistry of the groundwater used in this study is substantially different from that used in Pilot Project Treatability Study (particularly regarding arsenic concentration and phenol concentration) and removal of arsenic is not satisfactory additional tests with different doses of Fenton's reagent will be conducted.

#### 3.3.2 BENCH-SCALE PRETREATMENT

Bench-scale pretreatment will be conducted according to the procedures developed during the Pilot Project Treatability Study. The water collected at the Site will be pre-treated in 5-gallon batches. The pretreated water after separation of solids by settling will be used in one of the biological systems. The pretreatment will be conducted at a frequency sufficient to provide supply of the influent to long-term biological treatment operation. An excess of the pretreated water will be kept at 5°C in closed containers. As the supply of pretreated water is depleted, freshly pretreated water will be added to the same containers to maintain a supply of pretreated water for use in the biological system.

Samples of the treated groundwater from each batch treatment will be analyzed for pH, TSS, VSS, COD, TOC, DOC, phenols, arsenic, ammonia, nitrate, cyanide, and thiocyanate using analytical methods presented in Table 1.

During bench scale pretreatment, the settling time of precipitated solids and the necessity of using an organic flocculent, as was the case in the Pilot Project Treatability Study, will also be evaluated.

### 3.4 BIOLOGICAL TREATMENT

Biological studies will consist of the following activities:

1. acclimatization of biomass into raw and pretreated groundwater (3 to 4 weeks); and
2. long-term operation of separate SBR reactors (3 to 4 months).

#### 3.4.1 ACCLIMATIZATION

The purpose of acclimatization is to prepare the biomass to treat the target water. Since each water stream to be treated has a specific quality, microorganisms have to modify their metabolic processes to use particular components of the groundwater as a source of food and energy.

The biomass used in the studies will be collected from returned activated sludge at a wastewater treatment plant at the Bethlehem Steel plant in Buffalo, New York. This biomass was successfully used in previous treatability studies. The biomass will be shipped to the CRA Treatability Laboratory immediately after collection in three 5-gallon plastic containers. The containers will have enough headspace to maintain aerobic conditions during shipment. The dissolved oxygen concentration will be measured several times prior to shipping the containers. If the concentration of oxygen in the biomass is low ( $<2$  mg/L) and/or rapidly decreases then hydrogen peroxide will be added prior to shipping.

The following acclimatization procedure will be followed in the laboratory.

Initially the same amount of biomass, approximately 50 percent of the reactor volume, will be placed in three reactors SBR-1, SBR-2, and SBR-3 and aerated for 1 day. Samples of the biomass will be examined under the microscope every few hours to confirm the vitality of the microorganisms. Then two reactors (SBR-1 and SBR-2) will be fed with investigated groundwater (raw and pretreated respectively) while the third reactor

(SBR-3) will be used as a back up source of biomass in the case of any unexpected problems in operation of reactors SBR-1 or SBR-2. The biomass in the reactor SBR-3 will be aerated and fed with small amount of the groundwater fortified with ammonium chloride to maintain a sufficient concentration of the nitrifiers. The biomass from reactor SBR-3 will be used to supplement the biomass in SBR-1 or SBR-2, if necessary, to maintain effective nitrification.

Reactors SBR-1 and SBR-2 will be fed with small volume (approximately 100 mL) of raw (SBR-1) or pretreated (SBR-2) groundwater. After groundwater addition samples from both reactors will be collected and analyzed for pH, TSS, VSS, phenols, COD, SCOD, ammonia, and nitrate. After 1 day of aeration samples will be collected and analyzed for ammonia and nitrate only. If results of analyses indicate total transfer of ammonia nitrogen into nitrate nitrogen more groundwater will be gradually added to both reactors. Samples of supernatant from both reactors will be collected daily and analyzed for TSS, VSS, COD, SCOD, ammonia, and nitrate. Daily samples of the biomes will also be collected and examined under the microscope to assess the vitality and diversity of the microorganisms. No biomass will be wasted during acclimatization, unless excessive growth of mixed liquor volatile suspended solids (MLVSS) occurs.

Acclimatization of the biomass in a reactor will be completed when removal of ammonia will be sustained despite increasing the amount of groundwater added to the bioreactor for several days. At the same time microscopic examination of the biomass should indicate diversity and vitality of microorganisms.

### 3.4.2 LONG-TERM BIOLOGICAL TREATMENT

The purpose of the long-term biological treatment is to determine the optimum lengths of various stages of the treatment cycle and identification of any problems related to accumulation of inhibitory substances in the biomass. It is also expected that parallel operation of two biological systems one fed with raw groundwater while the other fed with pretreated water will provide useful information for the design of a full-scale treatment system as well as estimation of capital and operational costs.

To facilitate comparison of the two treatment systems, the same treatment strategy will initially be applied to SBR-1 and SBR-2. After, approximately 1 month of operation or one solids retention time (SRT), hydraulic retention time (HRT) will be gradually reduced to the value that still allows for stable nitrification. It is expected that the final HRT for reactor SBR-1 will be longer than that for SBR-2. It is also expected that some adjustment to operational parameters will be necessary to optimize treatment. An



application of organic polymers to improve solids settling and improve quality of the effluent will also be investigated in both biological treatment systems.

After both systems have produced good quality effluent for 1 month, a detailed evaluation of each of the treatment systems will be conducted. During the evaluation, both systems will be operated for three HRT cycles. After each cycle samples will be collected and analyzed for TSS, VSS, ammonia, nitrate, COD, SCOD, TOC, DOC, arsenic, phenols, and thiocyanate.

A schematic of the batch system used in the study is presented on Figure 3.1.

The initial strategy for both reactors will be:

Hydraulic Retention Time (HRT):	8 days
Solid Retention Time (SRT):	60 days
Mix Liquor Suspended Solids (MLSS):	10,000 mg/L

The SRT will be reduced as much as possible after a vigorous biological mass is established but will not be reduced below 30 days.

Operational parameters:

Non aerated/mixed fill	1 hour
Aerated fill	1.5 hour
Aerated react	5 hours
Settle	2 hours
Draw	0.5 hour
Dissolved oxygen	> 5 mg/L
pH	7 to 8

When minimum HRTs for SBR-1 and SBR-2 are determined the impact of various operational parameters (duration of fill, react and settle periods) on effluent quality will be investigated.

Samples of the effluent from both reactors will be collected daily and analyzed for TSS, VSS, COD, DOC, phenols, ammonia and nitrate. A composite of daily samples will be collected over a period of a few days to a maximum of 1 week and will be analyzed for arsenic, thiocyanate, and base/neutral and acid extractables. The base neutral fraction is unlikely to provide useful data and will be deleted after two iterations of sample collection.

An excess of biomass from both reactors will be wasted regularly to maintain the target MLSS value. Collected biological sludges will be analyzed for arsenic to determine accumulation of this metal.

In order to investigate any inhibitory effects on nitrification that may be the result of accumulation of metals and organic substances in the biomass the reactors will be run at optimum operating parameters for, at least three sludge retention times (SRT).

### 3.5 REPORTING

A report generated from the treatability study will consist of the following elements:

- Detailed testing procedures including sampling and analyses;
- Description of equipment used during the study;
- Summary of data from pre-treatment including tables and graphs demonstrating the effect of Fenton's reagent composition and concentration on the removal of arsenic, COD, thiocyanate and phenols;
- Analyses of data from biological treatment of the water that will identify the operational parameters affecting removal of organic substances, thiocyanate and ammonia;
- Summary of data from the whole treatment system that will allow optimization of the full-scale treatment plant; and
- Evaluation of the potential impact of re-injection of the effluent from the treatment plant into the aquifer on the groundwater quality.

### TREATMENT ASSESSMENT AND DATA ANALYSIS

Based on treatability studies results it is expected that the following goals will be accomplished:

1. Determination of nitrification efficiency for raw and pretreated groundwater; this will allow to estimate the costs of ammonia removal in each investigated options and evaluate the necessity of groundwater pretreatment;
2. Determination of arsenic fate during biological treatment and the impact of accumulation of arsenic in the biomass during nitrification; analyses of the

biomass for arsenic will also allow to determine if this phenomenon makes wasted sludge a hazardous wastes which would affect disposal; and

3. Treatment process design; treatability data will allow to design the full-scale process and estimate the sizes of specific treatment units and sludge generation rates.

### 3.6 TREATABILITY STUDY SCHEDULE

After arrival of the groundwater and activated sludge samples at the CRA Treatability Laboratory the following activities will be implemented:

#### Week 1

- i) Confirmation of Fenton's reagent treatment as described in Section 3.3.1
- ii) Acclimatization of the activated sludge in shipping containers to the water pretreated during optimization of Fenton's reagent treatment; and
- iii) Set-up of biological treatment systems.

#### Weeks 2 to 5

- i) Bench-scale pre-treatment of the groundwater using procedure described in Section 3.3.2; and
- ii) Acclimatization of the activated sludge in reactors SBR-1, SBR-2, and SBR-3, according to the procedure described in Section 3.4.1.

#### Weeks 6 to 10

- i) Start-up of two initial biological treatment trains using acclimatized activated sludge with and without pre-treated water;
- ii) Monitoring of the treatment system according to the procedure described in Section 3.4.2; and
- iii) TCLP test with solids generated during biological treatment of the groundwater without pretreatment.

#### Weeks 11 to 30

- i) Long-term biological treatment according to the procedure described in Section 3.4.2.

#### Weeks 31 to 34

Data compilation and evaluation of treatment as described in Section 5.0.

The nitrification schedule is long to achieve the objective of running a stabilized system for three solid retention times. With a minimum solid retention time of 30 days this step along will consume 90 days of schedule.

#### 4.0 SCHEDULE

The schedule for the GWPDSWP is illustrated on Figure 4.1. The schedule is intended to permit the modeling component to advance to a stage that confirms the Pilot Project conclusions about early reductions in groundwater parameter concentrations. This will provide added confidence that the sample collection strategy will produce water quality that is representative of long-term influent concentrations to the treatment system.

The nitrification schedule is long to achieve the objective of running a stabilized system for three solid retention times. With a target solids retention time of 60 days, this step alone will consume 180 days of schedule.

## 5.0 REFERENCES

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## FIGURES

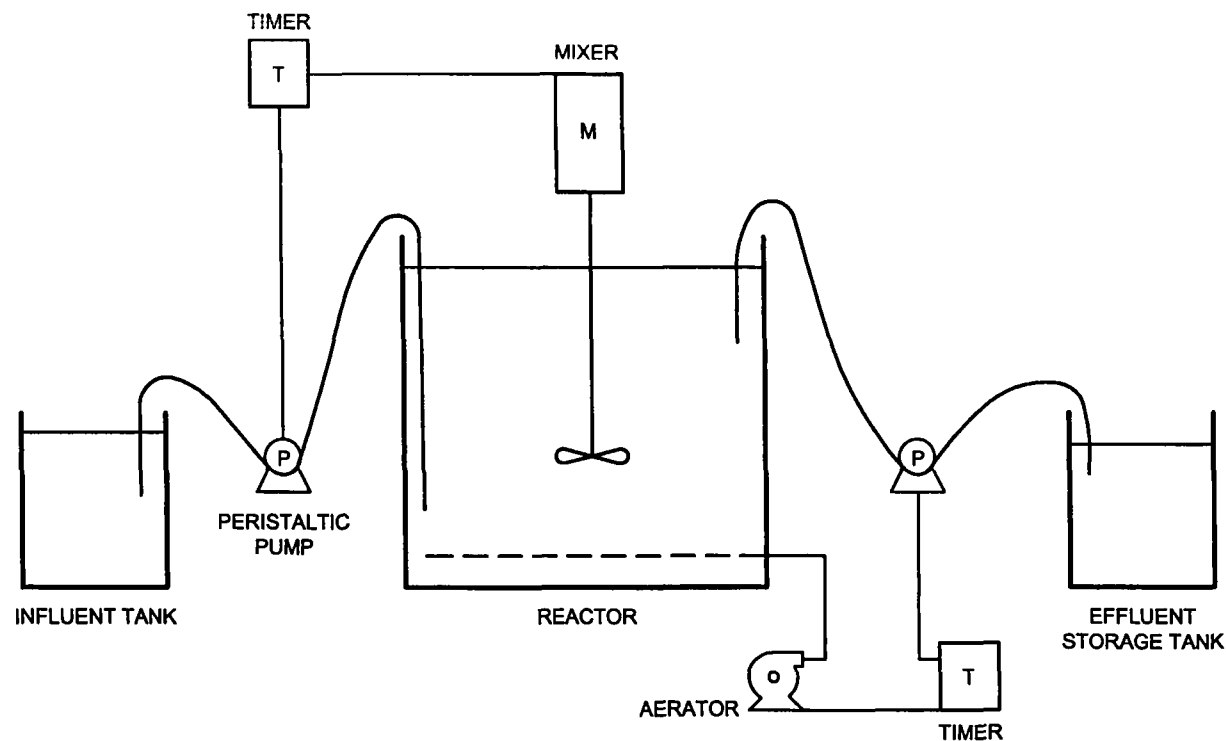
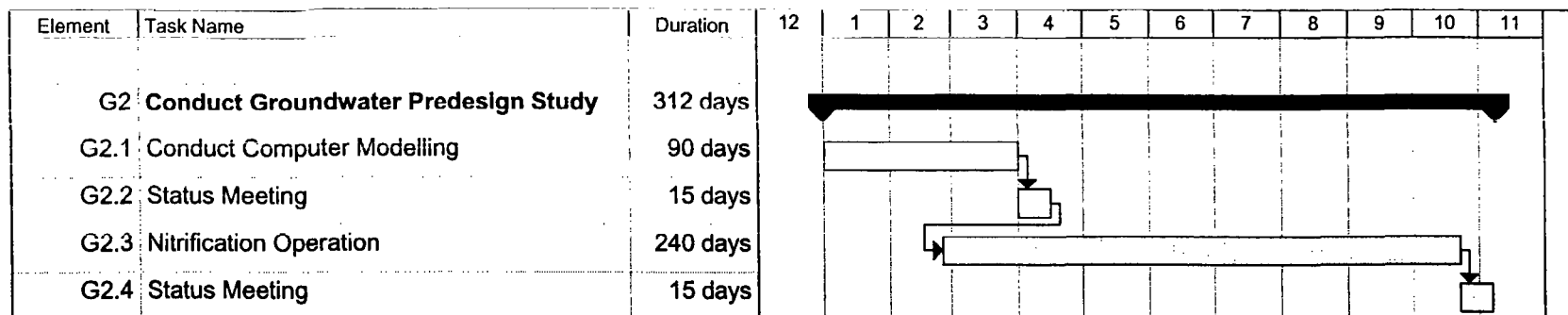


figure 3.1

BATCH TREATMENT SYSTEM SCHEMATIC  
NITRIFICATION STUDY  
WAUKEGAN MANUFACTURED GAS AND COKE PLANT SITE  
*Waukegan, Illinois*







Project: 19023 - Groundwater Predesi  
Date: Mon 1/21/02

Summary

Task

figure 4.1  
GROUNDWATER PREDESIGN SCHEDULE  
WAUKEGAN MANUFACTURED GAS AND COKE PLANT, Waukegan, Illinois

## TABLES

**TABLE 1**  
**LIST OF ANALYTICAL METHODS**  
**WAUKEGAN MANUFACTURED GAS AND COKE PLANT SITE**  
**WAUKEGAN, ILLINOIS**

<i>Parameter</i>	<i>Matrix</i>	<i>Method</i>
Total Phenolics	Water	EPA 420.2
Arsenic	Water	SW-846 6010B
Ammonia	Water	EPA 350.1
VOCs	Water	SW-846 8260B
SVOCs	Water	SW-846 8270C
Nitrate	Water	EPA 353.4
COD	Water	EPA 410.4
TOC	Water	SM 5310B
Cyanide	Water	EPA 335.4
Thiocyanate	Water	SM 4500-CN M
TSS	Water	EPA 160.2
VSS	Water	EPA 160.3
pH	Water	EPA 150.1
Turbidity	Water	SM 2130B
Conductivity	Water	SM 2510B